PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-055114
(43)Date of publication of application : 05.03.1993

(51)Int.Cl. H01L 21/027
G03B 27/32
G03F 7/20
G03F 9/00

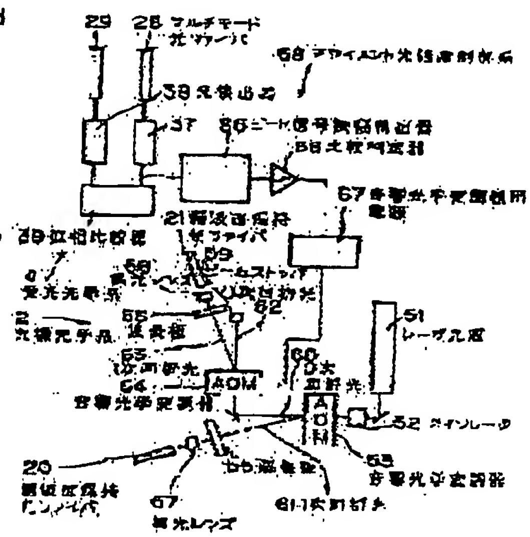
(21)Application number : 04-015525
(22)Date of filing : 30.01.1992

(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD
(72)Inventor : SAGAWA USHIO
YAMAMOTO MASAKI
KUBO KEIJI
SATO TAKEO

(30)Priority
Priority number : 03 94427 Priority date : 24.04.1991 Priority country : JP

(54) ALIGNER

(57)Abstract:
PURPOSE: To provide an aligner having a small-size and high-accuracy alignment optical system which is stable against an environmental change such as the fluctuation of air, vibration, heat, etc., regardless of the type of a projection lens.
CONSTITUTION: An alignment optical system is constituted of a light source optical system 2, a positional deviation detecting optical system and a photo detecting optical system 4. These three optical systems are combined with each other with plane-of-polarization maintaining optical fibers 20, 21 and multimode optical fibers 28, 29. In order to make an adjustment to the intensity of alignment light which enters the optical fibers 28, 29, the amplitude of a beat signal which has been converted into an electric signal by the photo detecting optical system 4 is detected by a detector 65 and a comparison and judgement device 66 outputs a signal which controls the output of a power supply 67 of an acoustic optical modulator 54 of the light source optical system 2 so that the detected amplitude may be fixed.



LEGAL STATUS
[Date of request for examination] 03.03.1993
[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	2079705
[Date of registration]	09.08.1996
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]

[Claim 1] The light source optical system which carries out outgoing radiation of the coherent alignment light in order to carry out alignment of the body placed on the image formation side of a projection lens, The location gap detection optical system which was connected to said light source optical system through the 1st optical fiber, and has been arranged near the projection lens, The light-receiving optical system which changes into an electrical signal the alignment light by which is connected to said location gap detection optical system through the 2nd optical fiber, and outgoing radiation is carried out from the 2nd optical fiber. It has an alignment light control system on the strength for making regularity the amplitude of the electrical signal from said light-receiving optical system. Alignment light is irradiated by whenever [specific incident angle] according to location gap detection optical system through said 1st optical fiber at the diffraction grating on said body from said light source optical system. Lead the diffracted light from said body to said light-receiving optical system through said 2nd optical fiber, and it changes into an electrical signal. The aligner characterized by adjusting the alignment luminous intensity which carries out incidence to said 1st optical fiber so that the objective amount of location gaps may be calculated from this electrical signal, the amplitude of said electrical signal may be further measured according to said alignment light control system on the strength and that amplitude may become fixed.

[Claim 2] Light source optical system is an aligner according to claim 1 characterized by having the light source which generates the coherent light of 1 cycle, and the acoustooptic modulator which carries out the sequential output of the diffracted light which is allotted to a serial on the optical axis and is slightly [a frequency] different.

[Claim 3] Light source optical system is an aligner according to claim 1 characterized by having the light source which generates the coherent light of 1 cycle, the beam splitter which divides said coherent light into the 2 flux of lights, and the acoustooptic modulator which carries out the sequential output of the diffracted light which carries out incidence of each flux of light divided into two, and is slightly [a frequency] different.

[Claim 4] An alignment light control system on the strength is an aligner according to claim 2 or 3 characterized by having a means to detect the amplitude of the electrical signal changed by light-receiving optical system, a means to output a control signal so that the amplitude of said electrical signal may become fixed based on said detection result, and a means to control the power supplied to an acoustooptic modulator with said control signal.

[Claim 5] Location gap detection optical system is an aligner according to claim 4 characterized by preventing the fall of location gap detection precision to the disturbance which has the criteria of location gap detection in the interior, and an optical fiber receives from a surrounding environment.

[Claim 6] The aligner according to claim 4 or 5 characterized by incorporating to location gap detection optical system since the diffracted light is reflected in respect of said coating from on a wafer while irradiating on a wafer, since the alignment light which irradiates on a wafer from location gap detection optical system is reflected in respect of coating of the lowest side of a projection lens.

[Claim 7] The aligner according to claim 6 characterized by enabling light-receiving of the newest thing when said diffraction grating is updated by carrying out image formation of the expansion image of the diffraction grating on a wafer to aperture by using one side of the 2nd optical fiber as a picture transmission optical fiber, and controlling the location of said aperture.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the aligner which imprints a certain pattern on a body through projection optics.
[0002]
[Description of the Prior Art] In recent years, densification of the semiconductor device used as the motive power of technological innovation is carried out increasingly, and the detailed pattern of each component tends to amount to 0.5 micrometers or less. In exposure of such a detailed pattern, in order to perform superposition exposure covering many times which is needed at the time of semi-conductor manufacture, the alignment during each exposure is very important, and, as for the superposition precision, 0.1 micrometers or less are needed. The configuration of a publication is known by JP,63-78004,A as a conventional example of such an alignment approach.
[0003] Hereafter, the conventional aligner is explained with reference to drawing 16 . In order to realize highly precise alignment, by grid 110,110of ** 1 to 1st' formed on the 114th page of a reticle in drawing 16 The inside of the flux of light by which wavefront splitting was carried out. A predetermined spectrum is alternatively passed by spatial filter 116,116' prepared near the spectrum side of 1st lens 115,115'. further -- the -- two -- a lens system -- 117,117 -- ' -- and -- projection -- a lens -- 119 -- passing -- making -- a wafer -- 118 -- a top -- having prepared -- one -- a pair -- the -- two -- a grid -- 121,121 -- ' -- a top -- projecting . If the 2 flux of lights are projected on 2nd grid 121,121' on a wafer 118 from a suitable direction, it will diffract in the direction with which the diffracted lights lapped, and each will interfere. this 1 pair of diffracted-light 122,122' in which it interfered -- hard flow -- the projection lens 119 and 2nd lens the 117,117' -- inside is passed, that diffracted-light reinforcement is detected by photodetector 123,123', and the highly precise alignment of a reticle 114 and a wafer 118 becomes possible by moving a wafer 118 so that those differences may serve as zero.
[0004]
[Problem(s) to be Solved by the Invention] However, with the above configurations, exposure light and alignment light are these wavelength mostly, and only when projection optics demonstrates the good image formation engine performance similarly to both, there is a problem of being effective. For example, since the glass ingredient for constituting dioptric system is restricted to ultraviolet radiation, such as excimer laser expected to become in use [exposure light] in the future, it is very difficult to constitute the achromatism projection optics which amended chromatic aberration. For this reason, the achromatism projection optics which amended chromatic aberration is designed so that color correction may fully be carried out only on exposure wavelength, very big chromatic aberration is shown to the light of other wavelength, and the configuration of an alignment system by which alignment light passes along a projection lens becomes very difficult. Moreover, when it is made a configuration whose alignment light does not pass along a projection lens temporarily, the exposure location of a wafer and the location which carries out alignment will separate a projection lens from the equipment configuration arranged so that it may cover and hang on a wafer greatly, and it has the problem

that superposition precision will fall.

[0005] This invention solves such a conventional problem, miniaturizes alignment optical system, makes it possible to place this in the middle of a projection lens and the body on an image formation side, and aims at offering the aligner objective alignment enabled it to perform with high degree of accuracy by this alignment system.

[0006]

[Means for Solving the Problem] This invention is equipped with the optical waveguide which has the flexibility which combines in order the light source optical system which carries out outgoing radiation of the coherent alignment light in order to attain the above-mentioned purpose, the location gap detection optical system which receives the diffracted light which irradiated said alignment light on the body and has returned, the light-receiving optical system which detects the diffracted light which received light, and said three optical system.

[0007]

[Function] Therefore, according to this invention, by combining location gap detection optical system, light source optical system, and light-receiving optical system by the optical waveguide which has flexibility, location gap detection optical system can be miniaturized and mounting to equipment can be made easy. Location gap detection optical system can be arranged directly under [only with the tooth space where it carried out and backlash was restricted extremely] a projection lens, and the aligner which has the highly precise alignment system which minimum-ized effect of vibration and atmospheric air and effect of heat deformation of equipment can be realized.

[0008]

[Example] Hereafter, the example of this invention is explained with reference to a drawing. Drawing 1 is the outline block diagram showing the basic configuration of the aligner in the example of this invention, and shows one shaft of the direction of X among the alignment systems of three shafts of X, Y, and theta. The outline block diagram of the location gap detection optical system which performs location gap detection of the wafer with which drawing 2 is used for the 1st example of this invention, and drawing 3 are the outline block diagrams of the light source optical system which combines with an optical fiber the laser beam by which outgoing radiation is carried out from the laser light source similarly used for the 1st example. The detail drawing of a laser light source having shown drawing 4 by drawing 3 , the mimetic diagram showing the work as a spatial filter of a collimator lens [in / in drawing 5 / the 1st example], and drawing 6 are the outline block diagrams of the light-receiving optical system for receiving the diffracted light from the wafer used for the 1st example.

[0009] In drawing 1 , the wafer which is the body with which alignment of 1 is carried out, the light source optical system in which 2 generates alignment light, the location gap detection optical system to which 3 irradiates alignment light on a wafer 1, and 4 are light-receiving optical system which receives the alignment light which has the location gap information on a wafer 1. As for exposure light and 7, the reticle whose 5 is the original recording of exposure, and 6 are [a projection lens and 8] alignment light. 20, the plane-of-polarization maintenance optical fiber which is the 1st optical fiber to which 21 connects the light source optical system 2 and the location gap detection optical system 3, and 28 and 29 are multimode optical fibers which are the 2nd optical fiber which connects the location gap detection optical system 3 and the light-receiving optical system 4, and the optical waveguide which has flexibility, respectively is constituted.

[0010] In the above configurations, the actuation is explained below. The alignment optical system in this example consists of the light source optical system 2, location gap detection optical system 3, and light-receiving optical system 4, and three optical system is mutually combined with the plane-of-polarization maintenance optical fibers 20 and 21 and multimode optical fibers 28 and 29. Moreover, the projection lens 7 carries out image formation of the pattern on the reticle 5 illuminated by the exposure light 6 on a wafer 1. Spacing of the projection lens 7 and a reticle 5 of this image formation is usually large because of about 5:1 contraction optical system, and spacing of the projection lens 7 and a wafer 1 is narrow. However, since the location gap detection optical system 3 in this example is made very small, it

is possible to place just under the projection lens 7.
[0011] As the light source optical system 2 is shown in drawing 4 , the frequency which carried out rectangular polarization mutually builds in the laser light source 12 which generates the coherent light of f1 and f2. In this example, the ZEMA in laser which obtains 2 cycles is used by applying a magnetic field to laser tubing.
[0012] As another example of such light source optical system 2, the optical modulator using the supersonic wave spread to an one direction and optical system which gives a difference to the frequency of the 2 flux of lights using the optical element to which the frequency of light is slightly changed using the Doppler effect after having the light source which generates the coherent light of 1 cycle and dividing this coherent light into the 2 flux of lights can be used. In addition, generally as a delta frequency of frequencies f1 and f2, dozens of kHz - dozens of MHz can use it.
[0013] In drawing 3 , the alignment light (the alignment light f1 and f2 is called hereafter.) which has the frequencies f1 and f2 which carried out outgoing radiation from the laser light source 12 turns into light which polarized in the specific direction using wavelength plates (lambda/2) 16 and 17, after being divided intofpolarization optical element 1 component and f2 component by 13. As a polarization optical element 13 for division, the thing using dielectric multilayers like a polarization beam splitter and the thing using two or more refraction like WORAN stone prism are usable. Moreover, although the polarization direction is rotated with wavelength plates 16 and 17, the reason is for doubling the polarization direction of the plane-of-polarization maintenance optical fibers 20 and 21, and the polarization direction of the alignment light f1 and f2.
[0014] With condenser lenses 18 and 19, it is condensed on the core of the plane-of-polarization maintenance optical fibers 20 and 21, and the alignment light f1 and f2 divided by the polarization optical element 13 for division is introduced in an optical fiber 20 and 21. In order to prevent reflection of the alignment light in an optical fiber 20 and 21 front faces returning to laser tubing, it is useful to insert optical isolators 14 and 15 in a suitable location. Moreover, since the core diameter of the plane-of-polarization maintenance optical fibers 20 and 21 is very small, the spot of the alignment light condensed by the light source optical system 2 may carry out the location gap of it, and it may reduce the joint effectiveness to optical fibers 20 and 21. For this reason, in order to make effect of thermal expansion or vibration into the minimum, it is necessary to make the light source optical system 2 high rigidity and small.
[0015] The plane-of-polarization maintenance optical fiber 20 and the alignment light f1 and f2 which carried out incidence into 21 are led to the location gap detection optical system 3 shown in drawing 2 , holding the polarization direction, respectively. The alignment light f1 and f2 which carried out outgoing radiation from the plane-of-polarization maintenance optical fibers 20 and 21 is led to collimator lenses 22 and 23, and is made into parallel light here. As collimator lenses 22 and 23, the wave-front precision of outgoing radiation light is high enough, and it is required that magnitude should be small. As such a lens, a gradient index lens (GRIN lens) and an aspheric lens are suitable. The alignment light f1 and f2 made parallel by collimator lenses 22 and 23 is irradiated through an incident light mirror 24 on the alignment mark 25 which consists of a diffraction grating on a wafer 1.
[0016] The angle of incidence theta to wafer 1 front face of the alignment light f1 and f2 sets the pitch of the diffraction grating of the alignment mark 25 on a wafer 1 to lambda, and the wavelength of P and alignment light is set up like a degree type (1) in it.
[0017]
Theta=sin -1 (lambda/P) ... (1)
[0018] If the alignment light f1 and f2 carries out incidence by such incident angle theta, both the alignment light f1 and f2 diffracted by the diffraction grating 25 will go up. Here, the field strength E1 and E2 of f1 and f2 is expressed like a formula (2) and a formula (3), respectively. However, it is the phase lag for the optical path length [as opposed to / as opposed to / in omega1 and omega2 / the angular velocity of f1 and f2 / the alignment light f1 and f2 of the plane-of-polarization maintenance optical fibers 20 and 21 in phi1 and phi2].
[0019]
E1=A1. cos (omega1 and t+2pi x/P+phi 1) ... (2)

[0020]
E2=A2, cos (omega2 and t-2pi x/P+phi 2) ... (3)
[0021] Since alignment light f1 and f2 is carried out in this way and progresses in the same direction, they interferes mutually and generates beat light from which the optical reinforcement is changes on a frequency (f1-f2) like a formula (4) as a result.
[0022]
Is=(E1+E2) 2 =A12+A22 +2A1, A2, cos (omega1-omega2) (t +4pix/P+ (phi1-phi2)) ... (4)
[0023] This beat light is again introduced to a multimode optical fiber 28 by the collimator lens 26, and the amount of location gaps of a wafer 1 is detected from this beat light. When the reason for using multimode optical fibers 28 and 29 is a multimode optical fiber, its core system is large, and since the alignment light f1 and f2 interferes and it has already suited that it is hard to be influenced of a location gap in case alignment light is recombined, it is because it is not necessary to hold a wave front.
[0024] By the way, the optical length of an optical fiber changes with temperature or stress a lot. For example, if the temperature of a 1m optical fiber carries out 1-degreeC rise, optical-path-length fluctuation of an about [a 10-20 wave minute] will be brought about. Moreover, when 1Pa of pressures concerning a 1m optical fiber changes, the optical-path-length fluctuation which is 10-6 to ten to five waves is brought about. if this has few differences between the environments where the plane-of-polarization maintenance optical fibers 20 and 21 are placed -- a formula (2) and a formula (3) -- it can set (phi1-phi2) -- it turns out that it changes and an error is produced in location gap detection. then, the beam sampler 30 -- this (phi1-phi2) -- it is placed in order to measure separately, and the alignment light f1 and f2 by which the rate was carried out in part with the beam sampler 30 is irradiated on the diffraction grating 32 of the same pitch as the wafer 1 formed on the glass plate 31. Since it is fixed, the diffraction grating 32 on glass 31 plate produces beat light. This beat light is expressed like a formula (5), when that optical reinforcement is set to Ir.
[0025]
Ir=A12+A22 +2A1, A2, cos (omega1-omega2) (t + (phi1-phi2)) ... (5)
[0026] It is led by the collimator lens 27 into a multimode optical fiber 29 like [this beat light] signal light. Placing aslant to alignment light is important for the glass plate 31 with which the diffraction grating 32 was formed here. It is because the reflection diffraction light 33 may be mixed with the reflection diffraction light from a wafer and location gap detection precision may be reduced, when the diffracted light is produced not only in the transparency direction but in the reflective direction and a glass plate 31 is perpendicularly placed to alignment light. Moreover, the half mirror arranged so that the alignment light f1 and f2 may be made to interfere mutually can also be substituted for the glass plate 31 with which the diffraction grating 32 was formed.
[0027] The diffraction grating 25 on a wafer 1 changes with each processes which a wafer 1 receives variously. It is the form which generally applied the transparent resist to alignment light on the irregularity formed with a semiconductor material, and acts as optical multilayers to alignment light in many cases. Since optical multilayers change in the polarization direction of light sensitively [an operation of opposite Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne.], whichever the alignment light f1 and f2 inclines toward [of P polarization (polarization in an incidence flat surface), or S polarization (polarization perpendicular to an incidence flat surface)] to the wafer 1, they becomes easy to be influenced of the surface state of a wafer 1 and is disadvantageous. For this reason, optical fibers 20 and 21 are fixed so that the 45 degrees of the polarization directions may incline at the outlet of the plane-of-polarization maintenance optical fibers 20 and 21. By carrying out like this, on the 1st page of a wafer, P polarization and S polarization become the rate of 5:5, and the bad influence which comes from the condition of a wafer 1 can be stopped to the minimum.
[0028] Here, considering the case where the front face of a wafer 1 is ruined with the aluminum pattern etc., the speckle from an aluminum pattern will also be blended in the diffracted alignment light (diffracted light) 34. The optical pattern on the focal plane when receiving such the diffracted light 34 by the collimator lens 26 (on the 28th page of a multimode optical fiber) is

shown in drawing 5 . It turns out that the alignment light 34 which eliminated the speckle light 36 is received by the core 35 of the multimode optical fiber 28 arranged in the center section so that clearly from this drawing. Thus, it turns out that a collimator lens 26 and a core 35 act also as a spatial filter to the alignment light 34.

[0029] Next, the light-receiving optical system 4 is explained using drawing 6 . In the light-receiving optical system 4, the alignment light transmitted with two multimode optical fibers 28 and 29 is introduced into the photodetectors 37 and 38, such as photomultiplier, and it changes into an electrical signal. If a phase comparator 39 detects the relative topology difference between two signals changed into the electrical signal, it becomes like a formula (4) and (5) to a formula (6), and the output proportional to the location gap x of a wafer 1 can be obtained.

[0030]

(Phase of Is)-(phase of Ir) =4pix/P ... (6)

[0031] Therefore, the location gap to the projection lens 7 of a wafer 1 can be lost by moving on the wafer stage 40 so that the amount of location gaps may become zero based on this output.

[0032] as mentioned above, from the light source optical system 2 arranged in this example in the location left with the body of an aligner Alignment light is led to the location gap detection optical system 3 placed directly under the projection lens 7 with optical fibers 20 and 21. Alignment light is irradiated on the alignment mark 25 of a wafer 1 from the location gap detection optical system 3. Again the diffracted light 34 from a wafer 1 to the light-receiving optical system 4 with optical fibers 28 and 29 Delivery, The beat light which had the location gap information on a wafer 1 with photodetectors 37 and 38 is changed into an electrical signal. Alignment of a wafer 1 to the projection lens 7 can be performed with high degree of accuracy by calculating the amount of location gaps of a wafer 1 with a phase comparator 39, moving the wafer stage 40 based on this, and controlling so that the amount of location gaps of a wafer 1 becomes zero.

[0033] As mentioned above, although explained using the 1st example per this invention, the advantage of this example is being able to keep away the laser light source 12 which miniaturizes the location gap detection optical system 3, and turns into a heat source from a delicate device part by having separated the light source optical system 2 and the light-receiving optical system 4 from the location gap detection optical system 3 using optical fibers 20, 21, 28, and 29 first. By miniaturizing the location gap detection optical system 3, the degree of freedom of arrangement within the aligner of this optical system 3 can increase, and the location gap detection optical system 3 can be arranged now in the very narrow location between the projection lens 7 and a wafer 1. For this reason, it becomes possible it not only can to perform new alignment in the location very near an exposure location, but to make into the minimum effect from the atmospheric air which is the easiest to serve as a detection error by laser interference measurement. Furthermore, optical system very strong against the disturbance of vibration and others is realizable by having installed the diffraction grating 32 which serves as criteria into the location gap detection optical system 3, and having constituted this optical-system 3 whole in the compact. Moreover, by not telling the heat from a laser light source 12 to the body of an aligner, deformation of a thermal device can be prevented and the stable alignment actuation can be guaranteed now. Since the alignment system is constituted using optical waveguide with very high flexibility called an optical fiber, mounting to equipment and optical-axis adjustment become very easy, and there are diversion to other equipments and an advantage of being easy further again.

[0034] Now, in the 1st example of the above, although the location and exposure location of alignment were the very near optical system for alignment (OffAxis alignment), in the 2nd example of this invention described below, the configuration of optical system for alignment (OnAxis alignment) which is the same is shown in drawing 12 from drawing 7 . In these drawings, the sign used for explanation of the 1st example of the above is used to the same element.

[0035] A thing important in case OnAxis alignment is performed is drawing alignment light into the exposure flux of light, without kicking exposure light. Generally, alignment light is drawn into exposure light with a dichroic mirror etc. using the difference in the wavelength of exposure light and alignment light. However, when arranging the location gap detection optical system 3 like this

time to a tooth space which is called between the projection lens 7 and wafers 1 and which was restricted extremely, it is impossible to use a dichroic mirror.

[0036] So, in the 2nd example of this invention, as shown in drawing 7 , the coating side 41 which is the lowest side of the projection lens 7 by which design manufacture was carried out only for exposure light is considered as substitution of a dichroic mirror. The coating side 41 shows about 100% of transparency effectiveness to exposure light, and it is designed so that it may have very low transparency effectiveness to alignment light. That is, the coating side 41 which is the lowest side of the projection lens 7 consists of a flat surface or a field where curvature is big, and acts as a nearly perfect reflector to the alignment light 8.

[0037] Next, the light source optical system 2 and the location gap detection optical system 3 in the 2nd example of this invention are explained. The light source optical system 2 has the 1st same configuration and same function as the light source optical system 2 in the example shown in drawing 3 . As location gap detection optical system is shown in drawing 8 , it differs to the 1st example shown in drawing 2 in that the mirror 42 is arranged again by return [the image formation lens 44 instead of a multimode optical fiber 28, and / fiber / 43 / image intermediary light transmission] instead of an incident light mirror 24 instead of the collimator lens 26. The image formation lens 44 is for carrying out image formation of the alignment mark (diffraction grating) 42 of a wafer 1 on the 43rd page of a picture transmission optical fiber, and a GRIN lens, and the small spherical surface and an aspheric lens can be used for it. As shown in drawing 11 , the image intermediary light transmission fiber 43 is an optical fiber by which melting unification was carried out, as many cores share a clad in one optical fiber, and can reproduce the image of an incidence end face to an outgoing radiation end face as it is. From this, the condition of the alignment mark 45 on a wafer 1 is reproducible in the light-receiving optical system 4 with the combination of the image formation lens 44 and the image intermediary light transmission fiber 43. Moreover, the clinch mirror 42 is used in order to turn the alignment light from the location gap detection optical system 3 to the coating side 41 of the projection lens 7 or to turn again to the location gap detection optical system 3 the diffracted light which reflected from the alignment mark 45 on a wafer 1, and was reflected in respect of [41] coating.

[0038] It reflects in respect of [41] coating of the lowest side of the projection lens 7, and, thereby, the alignment light in which outgoing radiation was carried out by the mirror 42 towards the upper part by return from the location gap detection optical system 3 enters in the flux of light of the exposure light 6. On the 1st page of a wafer, the two-dimensional diffraction grating 45 as shown in drawing 10 is formed. This diffraction grating 45 piles up the diffraction grating of the direction of X, and the diffraction grating of the direction of Y, the diffraction pattern of the direction of X detects a location gap, and the diffraction pattern of the direction of Y is for diffracting again the alignment light which carried out incidence aslant at the same include angle in the direction of slant. For example, when the angle of incidence over the wafer 1 of return and the alignment light 8 is alpha, it is determined by drawing 7 that the pitch Py of the direction of Y will serve as a degree type (7).

[0039]

2Py-sinalpha=nlambda (n= 1, 2, ...) ... (7)

[0040] Thanks to the diffraction pattern of such a direction of Y, the alignment light 8 can return to the location gap detection optical system 3 again, after being diffracted on a wafer 1.

[0041] Next, the light-receiving optical system 4 in the 2nd example is explained with reference to drawing 9 . The image of the outgoing radiation edge of the picture transmission optical fiber 43 is expanded with a magnifying lens 46, and the aperture 49 driven two-dimensional with actuators 47 and 48 there is arranged. It becomes possible to receive the alignment light only from that mark with a photodetector 38 through a condenser lens 50 to the alignment mark which is in the location of arbitration by this aperture 49. This situation is shown in drawing 12 . This drawing 12 shows signs that the thing of most right-hand side is chosen by aperture 49 among three alignment work pieces. An old alignment mark except this is not received with a photodetector 38.

[0042] The advantage which takes the configuration of such light-receiving optical system 4 can be explained as follows. That is, since an alignment mark breaks gradually as a wafer receives

process processing, the need of using a new alignment mark one after another produces it. In OnAxis alignment, since exposure locations are ** and an alignment location, this means that the location of the alignment mark 45 at the time of alignment shifts to the location gap detection optical system 3. Therefore, by detecting only the alignment light from the newest alignment mark 45, even if a location changes by moving the above-mentioned aperture 49, even if an alignment mark is updated. a high detection precision can be maintained. Drawing 12 also expresses signs that the old alignment mark is removed from the visual field of the light-receiving optical system 4.

[0043] As mentioned above, although explained using the 2nd example per this invention. In the 2nd example of this invention, the advantage that alignment is possible also during exposure is out of the advantage explained in the 1st example. For this reason, since alignment is correctly carried out to the projection lens 7 when a wafer 1 comes to an exposure location, it becomes possible to constitute an aligner which does not receive the effect of the movement precision of the wafer stage 40 in superposition precision.

[0044] as mentioned above, from the light source optical system 2 arranged in this example in the location left with the body of an aligner Alignment light is led to the location gap detection optical system 3 placed directly under the projection lens 7 with optical fibers 20 and 21. Alignment light is irradiated on the alignment mark 25 of a wafer 1 from the location gap detection optical system 3. Again the diffracted light 34 from a wafer 1 to the light-receiving optical system 4 with optical fibers 28 and 29 Delivery, The beat light which had the location gap information on a wafer 1 with photodetectors 37 and 38 is changed into an electrical signal. Alignment of a wafer 1 to the projection lens 7 can be performed with high degree of accuracy by calculating the amount of location gaps of a wafer 1 with a phase comparator 39, moving the wafer stage 40 based on this, and controlling so that the amount of location gaps of a wafer 1 becomes zero.

[0045] Next, the 3rd example of this invention is explained using drawing 13 . In this example, if light source optical system is removed, since it has the 1st and 2nd same configurations and same functions as the above-mentioned example, below, only light source optical system is explained.

[0046] As for 1 / 2 lambda-wave length plate, and 57 and 58, in drawing 13 , an isolator, the acoustooptic modulator with which the laser light source in which 51 generates the linearly polarized light coherent light of a single cycle, and 52 used 53, and 54 used the supersonic wave, and 55 and 56 are [a condenser lens and 59] beam stoppers. 20 and 21 are the plane-of-polarization maintenance optical fibers for combining with the location gap detection optical system 3 which described above this light source optical system 2.

[0047] The coherent light by which outgoing radiation was carried out from the light source 51 passes along an isolator 52, and is divided into the primary diffracted light 61 which received the zero-order diffracted light 60 which does not receive a modulation, and a modulation with the 1st acoustooptic modulator 53. The primary diffracted light 61 passes 1 / 2 lambda-wave length plate 55, and is combined with the plane-of-polarization maintenance optical fiber 20 with a condenser lens 57. Shortly, it separates into the zero-order diffracted light 62 which does not receive a modulation, and the primary diffracted light 63 which received the modulation, and the zero-order diffracted light 62 is prevented with the beam stopper 59, it goes into the 2nd acoustooptic modulator 54, and the primary diffracted light 63 is combined [the zero-order diffracted light 60 which did not receive a modulation passes 1 / 2 lambda-wave length plate 56, and] with the plane-of-polarization maintenance optical fiber 21 for it. Here, the isolator 52 is arranged in order to eliminate destabilization of the laser light source 51 by the light which is reflected from each optical element front face, and returns to a laser light source 51. 1 / 2 lambda-wave length plates 55 and 56 are inserted in order to make in agreement the plane of polarization of the primary diffracted lights 61 and 63, and the plane of polarization of the plane-of-polarization maintenance optical fibers 20 and 21. This is as the light source optical system 2 in the example of the above 1st having explained.

[0048] Unlike the light source optical system 2 in the 1st example shown in drawing 3 . the light source optical system 2 in this example writes a laser light source 51 in a single cycle from 2

cycles, and has the advantage that aggravation of the location gap detection precision by the mix lump of 2 cycles which had become a problem in said example is completely removable. Moreover, the rate of the beam of light which can be used as an alignment light among coherent light can be increased by having allotted two acoustooptic modulators 53 and 54 to the serial at one optical axis, without dividing coherent light.

[0049] namely, like the light source optical system 2 which shows the light source optical system 2 in this example to drawing 14 Although you may constitute so that it may become irregular with acoustooptic modulators 53 and 54, respectively after a beam splitter 64 divides into two In this case, if the intensity ratio to the incident light of the primary diffracted lights 61 and 63 in each acoustooptic modulators 53 and 54 is set to P1 and P2, respectively, the rate of the light which can be used as an alignment light among the coherent light from a laser light source 51 will become like a degree type (8).

[0050]

(P1+P2)/2 ... (8)

[0051] On the other hand, when the light source optical system 2 shown in drawing 13 is used, the rate of the light which can be used as an alignment light becomes like a degree type (9).

[0052]

P1+ (1-P1), P2 ... (9)

[0053] Therefore, as shown in these two formulas, there will be gain of only the quantity of light expressed with a degree type (10) by using the light source optical system 2 shown in drawing 13 .

[0054]

1/2, and(1-(1-P1) - (1-P2)) > 0 ... (10)

[0055] Since two or more alignment equipments are generally needed for an aligner again, when the alignment light reinforcement from a laser light source 51 is strong, by dividing alignment light on the way, this example can supply alignment light to two or more alignment equipments by one set of the light source, and the advantage that the heat source leading to a measurement error can be lessened produces it.

[0056] moreover, in order to depend for diffracted-light reinforcement on the frequency given to acoustooptic modulators 53 and 54 and to obtain a high beat light of contrast, usually Although the difference of the diffracted light on the strength is an alignment luminous-intensity difference as it is with the configuration which needs to arrange acoustooptic modulators 53 and 54 so that two alignment light reinforcement may become as equal as possible, and is shown in drawing 14 With the configuration shown in drawing 13 , an alignment luminous-intensity difference can be eased by arranging the acoustooptic modulator 53 with low reinforcement to the light source upstream.

[0057] As mentioned above, by this example, although explained using the 3rd example per this invention, since alignment light with high reinforcement and both the alignment luminous-intensity difference can be made small in addition to the advantage explained in the 1st and 2nd examples, a high beat light of contrast is obtained and there is an advantage which can raise alignment precision. Moreover, it also has the advantage that the mechanical strength of optical system can be raised, by the ability reducing the total of the component which constitutes optical system.

[0058] Next, the 4th example of this invention is explained using drawing 15 . In drawing 15 , although the light source optical system 2 is the same as the light source optical system 2 in the 3rd example shown in drawing 13 , the light source optical system 2 shown in drawing 14 may be used for it. Although the light-receiving optical system 4 is the same as the light-receiving optical system 4 in the 1st example shown in drawing 6 , the light-receiving optical system 4 in the 2nd example shown in drawing 8 may be used for it. Other configurations are the same as the 1st and 2nd examples of the above.

[0059] In drawing 15 , the beat signal amplitude detector by which the output of the photodetector 37 in the light-receiving optical system 4 is inputted into 65, the comparison test machine which outputs a control signal as the amplitude of a beat signal made regularity in 66, and 67 are the power sources for the acoustooptic modulator 54 of the light source downstream

into which the control signal from the comparison test machine 66 is inputted. The alignment light control system 68 on the strength is constituted by these. In addition, it may replace with a photodetector 37 and the output of a photodetector 38 may be inputted into the beat signal amplitude detector 65.

[0060] As explained in the 1st example, it is influenced from a surrounding environment, the amplitude and a phase become unstable, and the alignment luminous intensity by which outgoing radiation is carried out from the plane-of-polarization maintenance optical fibers 20 and 21 brings about aggravation of the location gap detection precision in the light-receiving optical system 4. So, in this example, the beat signal detecter 65 detects the amplitude of the beat signal outputted from the photodetector 37 of the light-receiving optical system 4, and feedback is applied to the power source 67 which supplies power to the acoustooptic modulator 54 of the light source downstream so that the amplitude may become fixed. By applying such feedback, it becomes possible to remove the effect by the environmental variation which joins all from the light source optical system 2 to the light-receiving optical system 4, and aggravation of the location gap detection precision by fluctuation of a beat signal on the strength can be prevented.

[0061] Inside acoustooptic modulators 53 and 54, the compressional wave which advances inside an optical material is generated by the ultrasonic vibrator of single frequency, and the coherent light which carried out incidence to acoustooptic modulators 53 and 54 is diffracted by the refractive-index distribution by the compressional wave. Since the compressional wave of an ultrasonic vibrator is a progressive wave, the diffracted light receives a kind of Doppler effect, and it receives the vibration frequency modulation only for vibration frequency of an ultrasonic vibrator. Since diffracted-light reinforcement is the function of the energy supplied to an ultrasonic vibrator when vibration frequency is fixed, it can control diffracted-light reinforcement by electric energy supplied to an ultrasonic vibrator.

[0062] As other examples to which feedback is applied and which control the alignment quantity of light, it is also possible to take the configuration of applying feedback to the power source for each acoustooptic modulators 53 and 54 so that the alignment light reinforcement by which outgoing radiation is carried out from the plane-of-polarization maintenance optical fibers 20 and 21 in the light source optical system 2 shown in drawing 14 may be measured and each alignment light reinforcement may always become fixed.

[0063] As mentioned above, although explained using the 4th example per this invention By having the alignment light control system 68 on the strength in this example in addition to the advantage explained in the 1st, 2nd, and 3rd examples It becomes possible to remove fluctuation of the alignment light reinforcement by the environmental variation which joins all from the light source optical system 2 to the light-receiving optical system 4, and has the advantage that aggravation of the location gap detection precision by fluctuation of a beat signal on the strength can be prevented.

[0064]

[Effect of the Invention] As mentioned above, in order to carry out alignment of the body placed on the image formation side of a projection lens according to this invention The light source optical system which carries out outgoing radiation of the coherent alignment light, and the location gap detection optical system which was connected to this light source optical system through the 1st optical fiber, and has been arranged near the projection lens. The light-receiving optical system which changes into an electrical signal the alignment light by which is connected to this location gap detection optical system through the 2nd optical fiber, and outgoing radiation is carried out from the 2nd optical fiber. It has an alignment light control system on the strength for making regularity the amplitude of the electrical signal from this light-receiving optical system. Alignment light is irradiated by whenever [specific incident angle] according to location gap detection optical system through the 1st optical fiber at the diffraction grating on a body from light source optical system. Lead the diffracted light from this body to light-receiving optical system through the 2nd optical fiber, and it changes into an electrical signal. Since the alignment luminous intensity which carries out incidence to the 1st optical fiber was adjusted so that the objective amount of location gaps might be calculated from this electrical signal, the

amplitude of that electrical signal might be further measured according to an alignment light control system on the strength and that amplitude might become fixed While being able to miniaturize location gap detection optical system and being able to make mounting to equipment easy It becomes possible to remove the effect by the environmental variation which joins all from light source optical system to light-receiving optical system. Aggravation of the location gap detection precision by alignment luminous-intensity fluctuation can be prevented, and the aligner which has the highly precise alignment system which minimum-ized effect of vibration, the effect of atmospheric, heat deformation of equipment, etc. can be realized.

[Translation done.]

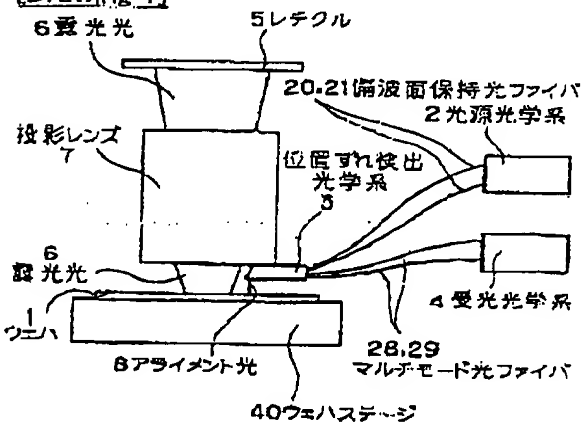
* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

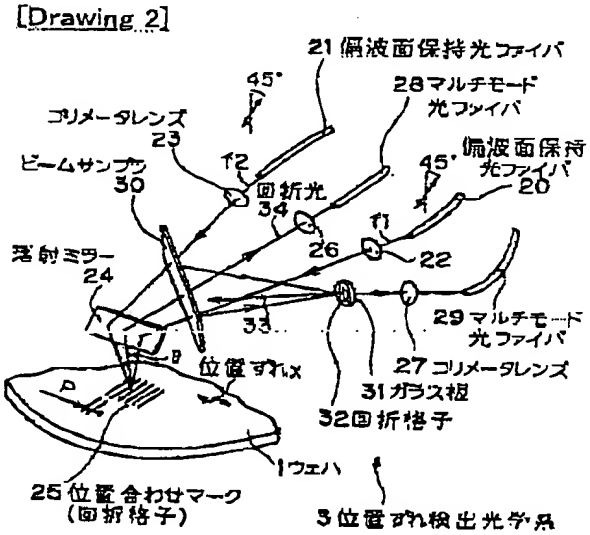
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

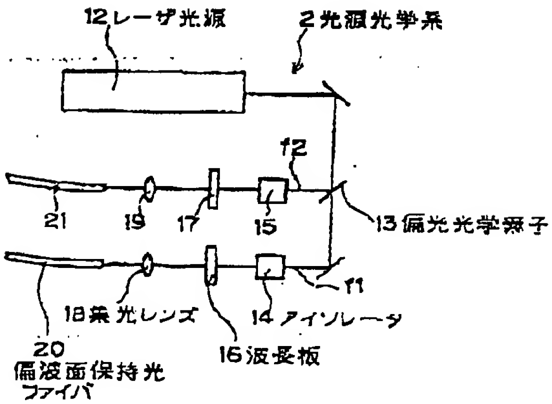
[Drawing 1]



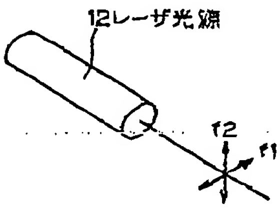
[Drawing 2]



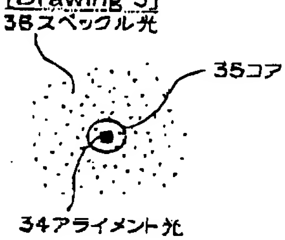
[Drawing 3]



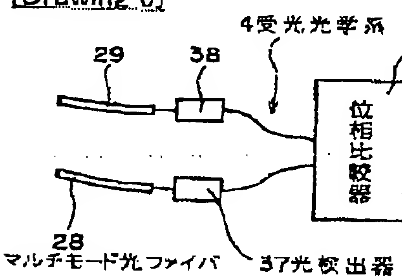
[Drawing 4]



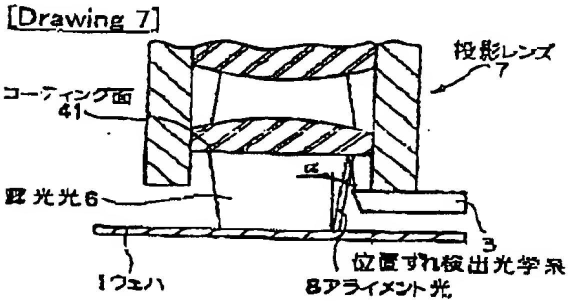
[Drawing 5]



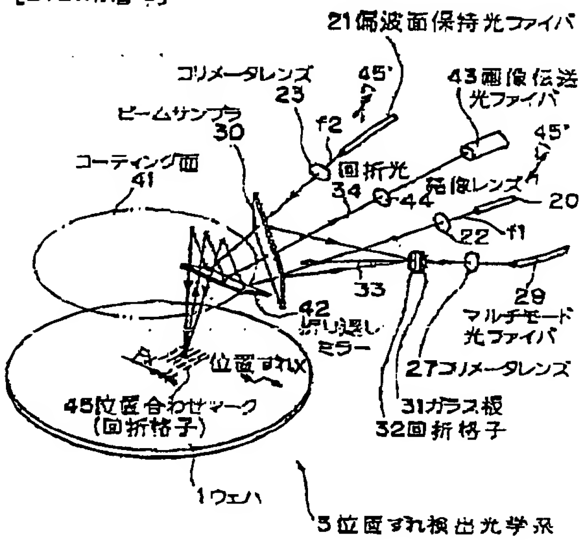
[Drawing 6]



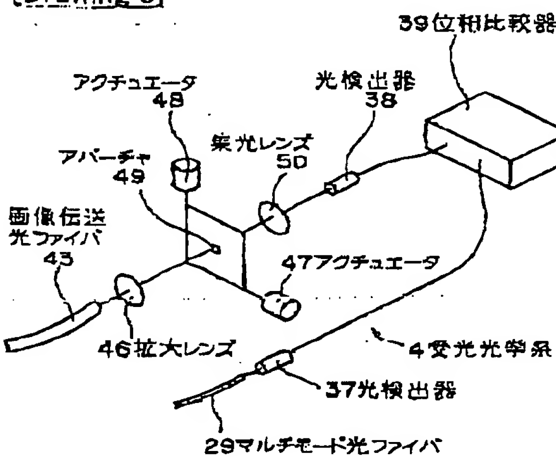
[Drawing 7]



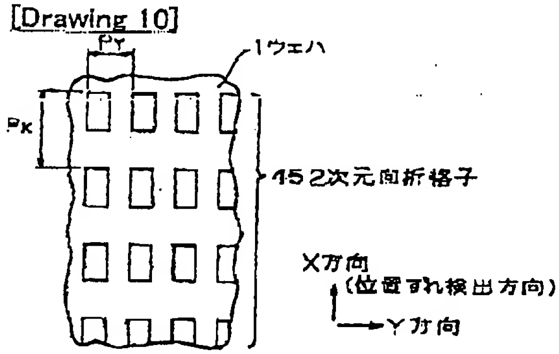
[Drawing 8]



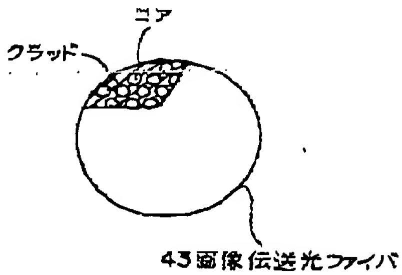
[Drawing 9]



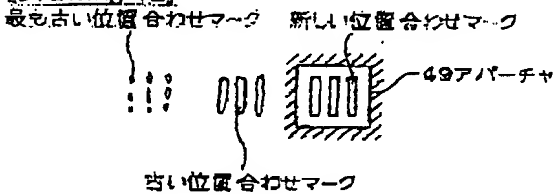
[Drawing 10]



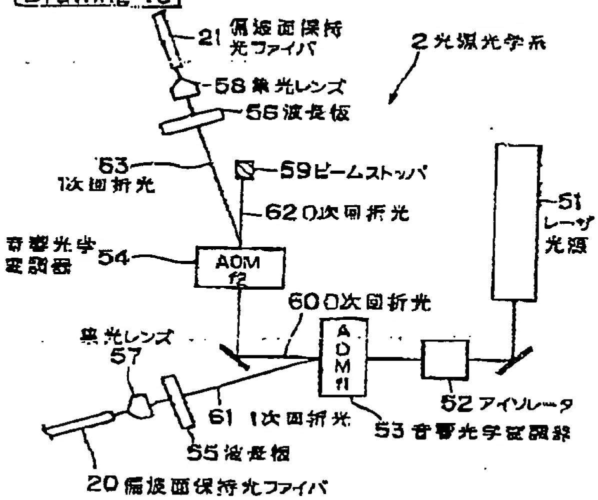
[Drawing 11]



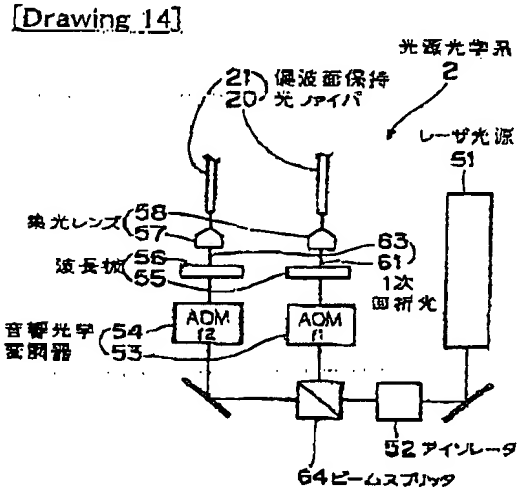
[Drawing 12]



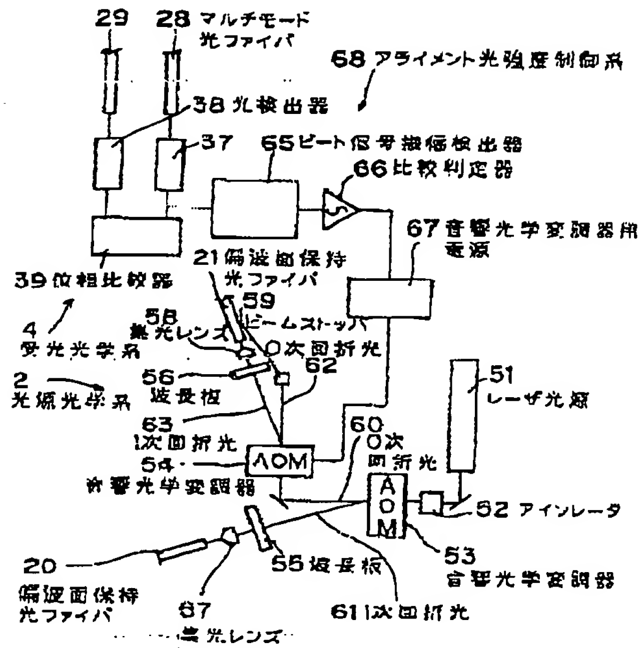
[Drawing 13]



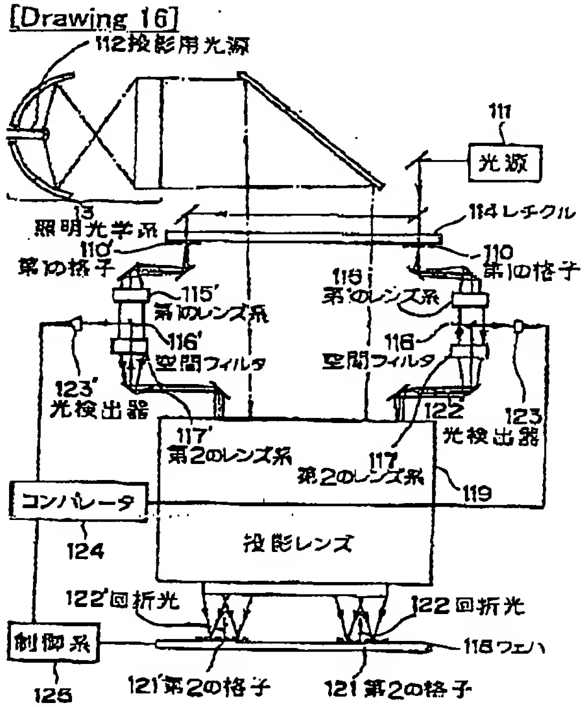
[Drawing 14]



[Drawing 15]



[Drawing 16]



[Translation done.]